An Energy Efficient Routing Protocol for WSN Assisting IoT

Abdul Wasay Mudasser, Shaik Mohammed Rasool, Shah Aqueel Ahmed Abdul Gafoor,
Research Scholar Himalayan University, Arunachal Pradesh,India.
Professor Department of E&TE, Maulana Mukhtar Ahmad Nadvi Technical Campus, Maharastra, India.
Wasay403@gmail.com

***Abstract*: In present modernized era Wireless Sensor Network (WSN) is used for many applications like Smart homes, Weather monitoring systems, Smart cities etc. and it is integrated into the (IoT). In this the nodes are resource strained in different ways, like energy resource, Storage resource, computing resource etc. To maintain a long network a powerful routing protocols are required. Here we proposed a technique for WSN using a routing protocol for energy efficient assisting IoT based on Hybrid optimization techniques to enhance the energy efficiency and network lifetime. A new series of hybrid algorithm is adapted for clusters and based on the center position cluster head(CH) which is rotated for distributing the energy between the sensor nodes. An advance technique is proposed for enhancing the network lifetime and energy utilization. A remaining energy is viewed in the proposed routing protocol in certain nodes to evaluate the center position. The proposed simulation result will show and compare with LEACH, LEACH-C, GEEC and the present existing EECRP. The proposed routing protocol will perform better than the existing system.**

Keywords: Wireless Sensor Network Clustering, Energy Efficiency, Internet of Things.

INTRODUCTION

In the 21st century, wireless and mobile communication success is too high. The different WSN merge with various wireless network to impart universal approach change ad achieve a dynamic scheduling algorithm which solves the throughput issues. For real time performance it is easier to alter the checking point cost depending on the energy level available in sensor system. It has long running computation scarce and low power Internet of Things (IoT) devices intermittent energy source [1]. A good device from independent energy supplies are IoT operations including medical transplant and sensors applicable in military which are prominent and hugely in demand [2], telemetry [3], intelligent building [4], and remote sensing usages [5]. Check pointing ranking is to determine maximum and minimum energy calculating the residual energy resource allocation.

IoT is also known as Internet of Everything it is the amalgamation of various techniques which contains web-based segments that collects, transmission and compute the data what they obtained from their ecosystem using embed sensors, processors and communication hardware. The next big revolution in the world of communication is predicted to be IoT [6]. The main purpose of IoT is to build a perfect network of every wireless devices which can communicated over the Internet. A IoT ecosystem has lot of units with enormous diversification scales from small sensors to large, dynamic data center nodes, the powerful execution setting, unambiguous nature of the data created by smart phenomenon, all these made IoT ecosystem as an atypical ecosystem [7]. Collecting physical data and converting it into valuable data and work include many operations, such operation requires a support from the IoT ecosystem. For detail, some applications are latency sensitive and some need complicated transforming like data and time series analysis [8]. IoT devices such as sensors have limited transforming and energy support, and they are not efficient of storing the huge data and to transmit out the complicated task. Thus there is need of powerful components to carry out transformation process required by IoT applications. these devices may be smart-phones, gateways and data centers [9].

Resource management incorporates performance monitoring, arrangement of network framework and firmware upgrades etc. [10]. The connectivity of resource management is generally placed at the IoT network end and produce all the applicable information at user end, where the vast number of devices and the data is handled by device manager. IoT is progression in computer technology and communication that aims to connect smart objects composed via Internet. Smart objects mean everything that environments can communicate or not [11]. The flow of events and data produced the interconnection of these objects is used to facilitate their coordination, tracking, management, control. The combination of various technologies and concerns are some of main defies achieving in order to take returns of this new archetype [12]. WSN can play a main role by gathering surrounding information and environment data. However, installing WSN design for accessing the novel challenges raised on internet, which requires to block before taking benefits of such considerations [13]. The major challenge of IoT is the restrictions of resources like, supply of energy, power processing, memory space, wireless communication bandwidth and range, which influence the routing in multiple ways [14]. The direction of the short range shows that the routing should be done in a multi-hop mode, i.e. in

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Abdul Wasay Mudasser, Shaik Mohammed Rasool, Shah Aqueel Ahmed Abdul Gafoor,
Research Scholar Himalayan University, Arunachal Pradesh,India.
Professor Department of E&TE, Maulana Mukhtar Ahmad Nadvi Technical Campus, Maharastra, India. Wasay403@gmail.com

order to reach their destination the data packets should be send by multiple relay nodes. The routing technique flowing on IoT tool should be well optimized and light weighted or low power processing and program memory. The shot communication and small storage memory capacity may curb the amount of the packets to be send. The short energy source frame it hard to finalize which nodes must send the data packs as wireless communication influences energy utilization of IoT systems [15].

I. RELATED WORK

An energy-aware trust derivation scheme for WSNs that minimizes latency and energy utilization for the system under the state of security provision. This method derives the optimal amount of directions using trust derivation dilemma game(TDDG) to compute the (TDDG) method to minimize the burden of the network. The different with the Nash equilibrium, the optimal relationship of cost to gain and the possibility of the selected plan are considered. Considering a large simulation which shows this approach not only maintain the useful security for the network, but also crucially decreases the latency and energy consumption of the network [16].

Investigation of relationship between clustering and routing and proposed a joint clustering routing (JCR) protocol for good and effective data collection in large-scale WSN. JCR adopted back-off timer and gradient routing to generate attached and effective inter-cluster topology with the limitation of maximum communication range. In JCR the relationship between clustering and routing are also used by theoretical and numerical analysis. In JCR the multi-hop routing may conduct the unstable cluster head selection to optimize the lifetime of the network by selecting the gradient of one-hop neighbor nodes in the setting of back-off timer [17].

A balanced energy adaptive routing (BEAR) protocol, which aims to extend the lifetime. The BEAR protocol works in three stages are data transmission phase, initialization phase and tree construction phase. The initial stage converts all nodes allocation information associated to their remaining energy level and position. The tree establishment stage utilizes the position information and choosing neighbor nodes and selecting the fast and successor nodes depending on the amount of cost operations. A balanced energy consumption is formed among the successor and the fast nodes, BEAR selects nodes with approximately higher balanced energy than the average balanced energy of the network [18].

A trust-based system for secure routing (SCOTRES) for ad-hoc networks, a five novel metrices are applied for advancing the intelligence of network system. The energy metric recognizes the service utilization of every node, striking equivalent amount of participation for improving the duration of the network. The network topology metric is familiar of the nodes locations and improves load-balancing. The channel-health metric produce tolerance in regular break due to poor channel conditions and save the network against jamming strikes. A reputation metric calculates each contribution for specific network performance, observing specialized strikes, while the trust metric evaluates the overall compliance, protecting against combinatorial strikes [19].

Four distributed algorithms are fixed clustering, grid flooding, and grid sink-based routing for event detection in WSN. It requires node to know their location, using GPS or running a location computation mechanism. The grid flooding consumes the most energy but achieves the highest rate of complex occurrence managed strongly at the sink. The grid sink-based routing consumes the least energy among the four algorithms but achieves the lowest rate of complex occurrence managed strongly at the sink. The tree-based routing and anchor-based routing are using event-based clustering, where nodes do not need to know their location. Anchor-based routing is more energy-efficient than tree-based routing, but it may result in longer paths, and a slightly less percentage of composite occurrence managed strongly at the sink [20].

An edge-aware inter-domain routing (EIR) protocol, which impart ideas are virtual-links (vLinks) and aggregated-nodes (aNodes). Particular use-cases addressed by EIR involve developing flexibility work layout like various homing over WiFi, cellular, multipath routing across multiple network connections and any-cast connection from cellular equipment to reduce cloud work. EIR used to notice capable routing plans for the strength scenario under discussion, while contributing backing for a field of inter-domain routing method presently correlated with BGP [21].

A data delivery framework for disaster management, various wireless sensors were allocated up the city traffic-framework, parking areas of shopping centers and airport facilities. This framework serves for energy-efficient usage in the IoT and transmitted via relays from various sensor nodes towards a gateway link to a large-scale network such as the Internet. The entire network energy is selecting the next hop for the routed packets in the focused WSNs with the consideration of resource limitations by means of remaining-energy levels and hop count [22].

Investigation of three active queue management (AQM) schemes such as proportional integral controller enhanced (PIE), controlled delay (CoDel) and flow queue-CoDel (FQ-CoDel) for deployment on ISP and consumer sides of home broadband links. The different traffic mixes are competing with IoT flows at different network conditions like, Internet connection bandwidths and path delays. FQ-based algorithms provide the excellent capacity sharing and good protection in terms of throughput and delay for the IoT flows in all examined cases, which cannot be fulfil with single queue PIE or FIFO queue management. The benefits of FQ-Codel and FQ-PIE are visible under highly constrained situation, where applications that accept adaptive streaming plans are protected from security damage [23].

The challenges of enabling energy monitoring and control in smart buildings using low-bandwidth power line communication Insteon protocol. The deployment and architecture for whole-house monitor and control using Insteon, and empirically quantify the limitations of the Insteon protocol. A various method for switch event correlation and smart polling used in our deployment, which address the restrictions of low-bandwidth power line communication (PLC) with concentration on correlating switch events with a whole-house power meter and polling energy application on highly working devices. The smart polling methods exceed simple polling access in checking efficiency and entire bandwidth utilization, with developing the possibility and capability of less-bandwidth, modest control networks [24].

A search economics (SE) IoT resource allocation (SEIRA) algorithm, which provides an useful way to search for the results of complicated optimization issues. SEIRA are the way where the results are encoded, where the primary results are generated, and the active local search operator. Moreover, because SE-based algorithms will store not only the data collected from the search process to search for high potential areas in the result space but also the search difference, the simulation effects of this algorithm shows better than other algorithms for IoT resource distribution issues. However, to develop some efficient methods to drat the whole results storage to provide more applicable data for the search algorithm, the growth of SE is how to enhance full efficient and effective transit operator is also the target [26].

II. Research Methodology

Shen et al. [26] have proposed a routing technique which is centroid based assisted IoT, which improves the network behavior. EECRP involves three main segments which are a spread cluster evolution method which allows the self-establishment of internal nodes, a sequence of algorithm is now modifying clusters as well as spinning the cluster head (CH) situated at center position into uniformly distribute effective energy pack between complete sensor nodes along with new technique to decrease effective energy utilization for high range communication. In EECRP consider excess energy based on nodes or evaluating the center position. The outstanding short-term validity of wireless sensors and invaluable substitution, reconstruction of the elements is not worthful. Still, the major issues of WSN assisted IoT is tan energy efficient and more life routing. Truly it may occur more than single real-world objects efficient to execute the same task. Hence tasks need to be well organized to world objects capable. Therefore, the routing is efficient as energy, processing capabilities, transmission bandwidth, data storage, provided that problems demand quality conditions were still fulfilled. In a conventional multi-cloud domain structure, a user sends a request to a working user stating the description of the necessary services. The user must find the suitable services and a service provider or a group of providers which fulfil the request. Presently for the IoT the main challenge is to find the best service which fulfills the user needs and the situational targets for that it required efficient routing protocol to enhance the energy utilization and network lifetime. Network heterogeneousness and diversification of IoT machine makes routing as a defy task, various algorithms and methods are being recommended which is used to resolve the service allotment issue. The paper addresses the same issues in routing protocols.

III. Existing Model

In this a randomly distributed wireless sensor node network is considered. The entire WSN was arranged and computed, in this the position of wireless sensor nodes was not modified. Moreover, when the network is established the location data of sensor nodes were filled into the nodes. It was assumed that every node recognizes the position of BS and rest energy by every time. Direct communication with BS is considered in EECRP and CH nodes. To evaluate the behavior of EECRP the main matrix is sensor energy model. A clustering technique was adopted to observe the suitable CH nodes for clusters [26].

IV. Our Contribution

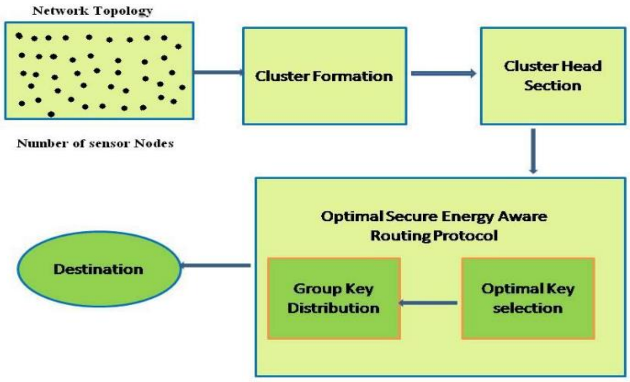

Fig. 1: Proposed Model

In proposed model, a multi-objective swarm optimization (MSO) algorithm is used to perform the clustering, which reduce the chaotic in nature of energy consumption. Then, multi-service queue-based ant optimization algorithm technique is used for selecting next neighbor nodes for inter clustering routing. Moreover, proposed method preserves the energy efficiency and network lifetime in high density sensor networks.

V. Results and Discussion

A. Simulation Tools

Network Simulator (NS-2) tool designed particularly for research in the area of wireless communication and computer networks. It is an open source software tool which imparts valuable support to simulate set of internet protocols. The NS-2 simulates wired as well as wireless networks. In NS2 the network protocols are defined by every user which simulates their relative operations.

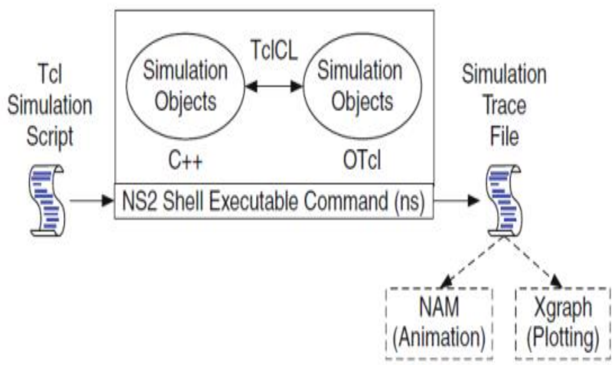

Fig 2: NS-2 Architecture

Network Simulator (NS-2) tool was implemented for Proposed Routing Protocol. The NS-2 architecture allocates computing with executable instructions ns which is considered to be input evidence. In maximum cases a simulation creates a duplicate file which marks a graph or produce animations.

B. Performance Assessment:

The execution of the proposed routing protocol will be assessed on NS-2 simulation tool depending on energy utilization and lifetime of the network.

1. Energy Consumption:

The proposed routing protocol will frame the entire energy consumption in normalized form and consumption of Energy is described as overhead nodes of communication where in a network solid amount of false data are placed.

$$Energy = Power \times Time$$

The implementation analysis of energy efficiency in IoT devices will be considered. The energy efficiency of the proposed system will be superior than the existing system up to 100 nodes that accordingly give dominance to the proposed algorithm. whereas suggested algorithm evaluates the entire network lifetime equally and calculates preventive measurements.

2. Simulation Parameter:

Considering the BS location and comparing LEACH, LEACH-C using the ns-2 simulator. In simulation considering 100m x 100m network with 100 nodes distributed in the network randomly. The primary energy will be set as 2J at each node. Moreover, in the sensor network BS is located using ns-2 simulator LEACH, LEACH-C, GEEC, EECRP and proposed routing protocol will be implemented using ns-2. Our simulation parameter details were listed in Table 1.

TABLE 1: Simulation Specifications

Specifications	Utility
Network Area	100x100
BS Position	Indoor
Sensor nodes	100
Primary Energy (J)	2
Transmitting/ Receiving Energy(NJ/bit)	50
Data range (bit)	500
MAC Standard	802.11
Bandwidth (Kbps)	200
Beam Energy(NJ/bit)	5

Considering the three performance measurement parameters, the total nodes that are active, total massages received at BS and total dissipated energy. When the last nodes were insufficient to form clusters, the duration of the network is considered and established.

C. Simulation Results:

Here we will consider the active nodes and calculate the setting of the simulation parameters are the transmitted data size and overall network energy dissipation in the network area with located BS.

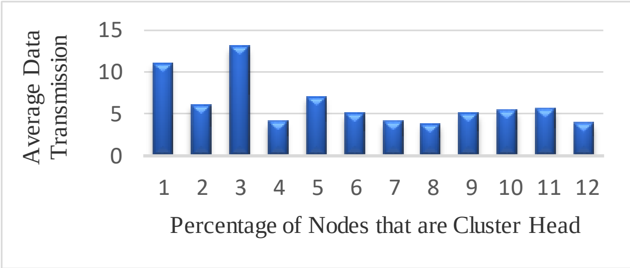

Fig 3: Inactive first and last nodes

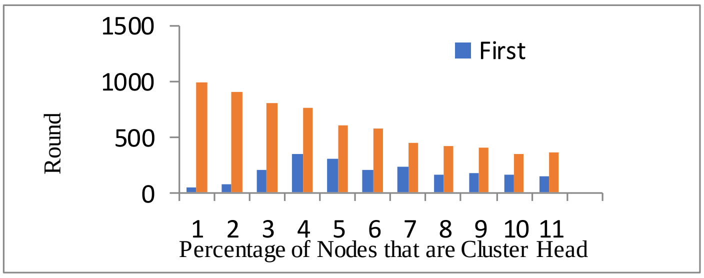

Fig. 4: Average transmission data with different values

The Fig. 4 shows fewer larger CH nodes with the average transmission data network, which clearly indicated the poor integrity data.

In all situations the sensor will be in poor condition when CH nodes are in large number in the sensor network, when lifetime of a sensor will be shorter, data transmission is smaller and the energy dissipation leads to shortages of network quickly [26].

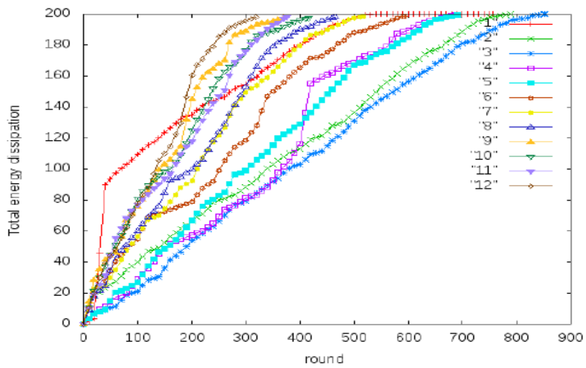

Fig. 5: Energy Dissipation with different values

Considering all the characteristics for setting up of CH nodes percentage to 5% which causes a better state of the network. The dissipation of nodes energy is slow when node dies, it is difficult to establish the network size when it is not monitored continuously. The best setting of CH nodes should be 5% which influence the dissipated energy rate and lifetime [26].

D. Observations:

The four existing routing protocols mentioned in table 2 were considered each protocol will be examined in three different aspect. Energy dissipation, number of active sensors, the amount of information received by BS. For the performance evaluation the existing protocols several matrices will be taken into consideration when the position of the BS is inside the network.

Energy Dissipation: In term of Energy Consumption EECRP and GEEC have homogeneous performance. The of LEACH-C performance is not good compare to EECRP GEEC and LEACH [26]. The EECRP energy consumption is slower than LEACH and can monitor the network for longer time as shown in the Fig. 6.

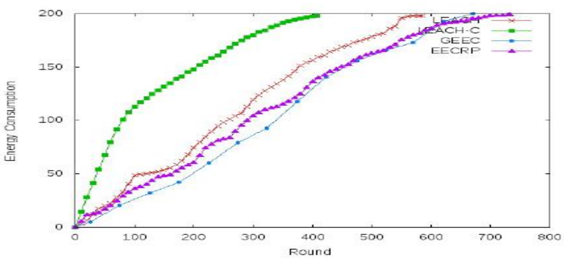

Fig. 6: The total dissipation energy

Number of active sensors: It is the most important parameters of routing protocols which shows the lifetime of WSN's. The Fig. 7: shows the difference in the number of active sensor nodes among all existing protocols which are considered. In LEACH-C at 100th round approximately the first node dies, whereas for other protocols at 400th round approximately the first node dies. The second nodes of LEACH-C dies because of excess amount f transmission control message at a very limited period of time. Whereas the lifetime of other protocols is more than 100 rounds approximately [26].

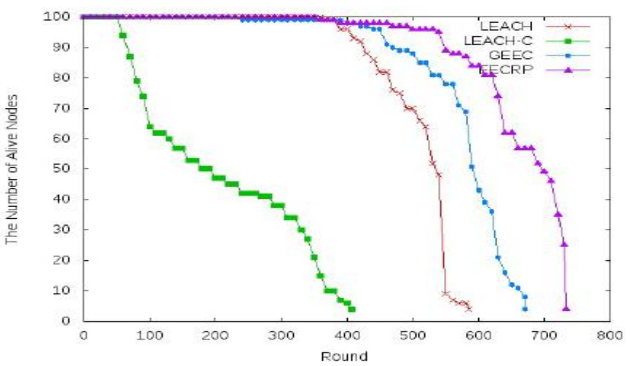

Fig. 7: The active sensor nodes

The amount of information received by the BS: few messages are delivered to BS by LEACH-C compare to other protocols. Before the 400th round the numbers of messages are received in the network by BS which is applicable for other protocols which are identical. Whereas EECRP slowly improves the packet delivery. In the network the distance between two nodes increases when more number of nodes die. The messages of all the nodes are stored in spaces [26].

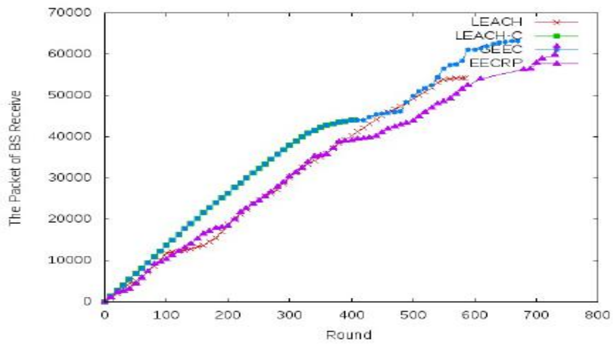

Fig. 8: The amount of information received by the BS

E. Discussions:

The characteristics of existing and proposed routing protocol will be performed and compared as shown in Table 2. To compare the protocols the parameters which are used are rounds, capacity, system overhead, track selection, position knowledge, strength. The proposed routing protocol for energy efficient will perform better than the existing protocols in terms of all the parameters.

Table 2: Comparison among Routing Protocols.

Protocol characteristics	LEACH	LEACH-C	GEEC	EECRP	Proposed Protocol
Rounds	540	480	670	720	780
Capacity	Poor	Poor	Good	Good	Good
System Overhead	Establish and Maintain cluster	Establish and Maintain cluster	Establish and Maintain cluster	Establish and Maintain cluster	Establish and Maintain cluster
Track selection	Single	Single	Single	Single	Multiple
Position knowledge	No	Fine	Fine	Fine	Fine
Strength	Fast	Fast	Fast	Fast	Fast

VI. CONCLUSION

Here we proposed a new technique for WSN using a routing protocol or energy efficient assisting IoT by resolving the issues. We also proposed a technique depends on number of nodes which are inactive and cluster head. In this paper four different routing protocols performance were studied where the proposed routing protocol will have low energy dissipation for transmitting a considerable amount of data. The network life time of the prepared protocol will be longer than LEACH, LEACH-C, GEEC and EECRP.

REFERENCES

[1] M. Gao, Q. Wang, M. Arafin, Y. Lyu and G. Qu, "Approximate computing for low power and security in the Internet of Things", Computer, vol. 50, no. 6, pp. 27-34, 2017.

[2] S. Bolisetti, M. Patwary, A. Soliman and M. Abdel-Maguid, "RF Sensing Based Target Detector for Smart Sensing Within Internet of Things in Harsh Sensing Environments", IEEE Access, vol. 5, pp. 13346-13363, 2017.

[3] U. Satija, B. Ramkumar and M. Sabarimalai Manikandan, "Real-Time Signal Quality-Aware ECG Telemetry System for IoT-Based Health Care Monitoring", IEEE Internet of Things Journal, vol. 4, no. 3, pp. 815-823, 2017.

[4] D. Minoli, K. Sohraby and B. Occhiogrosso, "IoT Considerations, Requirements, and Architectures for Smart Buildings – Energy Optimization and Next Generation Building Management Systems", IEEE Internet of Things Journal, pp. 1-1, 2017.

[5] S. Abdelwahab, B. Hamdaoui, M. Guizani and A. Rayes, "Enabling Smart Cloud Services Through Remote Sensing: An Internet of Everything Enabler", IEEE Internet of Things Journal, vol. 1, no. 3, pp. 276-288, 2014.

[6] E. Welbourne, L. Battle, G. Cole, K. Gould, K. Rector, S. Raymer, M. Balazinska and G. Borriello, "Building the Internet of Things Using RFID: The RFID Ecosystem Experience", IEEE Internet Computing, vol. 13, no. 3, pp. 48-55, 2009.

[7] G. Broll, E. Rukzio, M. Paolucci, M. Wagner, A. Schmidt and H. Hussmann, "Perci: Pervasive Service Interaction with the Internet of Things", IEEE Internet Computing, vol. 13, no. 6, pp. 74-81, 2009.

[8] M. Kranz, P. Holleis and A. Schmidt, "Embedded Interaction: Interacting with the Internet of Things", IEEE Internet Computing, vol. 14, no. 2, pp. 46-53, 2010.

[9] P. Giner, C. Cetina, J. Fons and V. Pelechano, "Developing Mobile Business Processes for the Internet of Things", IEEE Pervasive Computing, vol. 9, no. 2, pp. 18-26, 2010.

[10] D. Guinard, V. Trifa, S. Karnouskos, P. Spiess and D. Savio, "Interacting with the SOA-Based Internet of Things: Discovery, Query, Selection, and On-Demand Provisioning of Web Services", IEEE Transactions on Services Computing, vol. 3, no. 3, pp. 223-235, 2010.

[11] M. Zorzi, A. Gluhak, S. Lange and A. Bassi, "From today's INTRAnet of things to a future INTERnet of things: a wireless- and mobility-related view", IEEE Wireless Communications, vol. 17, no. 6, pp. 44-51, 2010.

[12] S. Hong, D. Kim, M. Ha, S. Bae, S. Park, W. Jung and J. Kim, "SNAIL: an IP-based wireless sensor network approach to the internet of things", IEEE Wireless Communications, vol. 17, no. 6, pp. 34-42, 2010.

[13] M. Shadaram and M. Rehmani, "Introduction to the Special Issue on ‘‘Wireless Systems: Networks, Routing, Security and Reliability”", Computers & Electrical Engineering, vol. 41, pp. 157-158, 2015.

[14] K. Nguyen, M. Laurent and N. Oualha, "Survey on secure communication protocols for the Internet of Things", Ad Hoc Networks, vol. 32, pp. 17-31, 2015.

[15] P. Bellavista, G. Cardone, A. Corradi and L. Foschini, "Convergence of MANET and WSN in IoT Urban Scenarios," in IEEE Sensors Journal, vol. 13, no. 10, pp. 3558-3567, Oct. 2013.

[16] J. Duan, D. Gao, D. Yang, C. H. Foh and H. H. Chen, "An Energy-Aware Trust Derivation Scheme With Game Theoretic Approach in Wireless Sensor Networks for IoT Applications," in IEEE Internet of Things Journal, vol. 1, no. 1, pp. 58-69, Feb. 2014.

[17] Z. Xu, L. Chen, C. Chen and X. Guan, "Joint Clustering and Routing Design for Reliable and Efficient Data Collection in Large-Scale Wireless Sensor Networks," in IEEE Internet of Things Journal, vol. 3, no. 4, pp. 520-532, Aug. 2016.

[18] N. Javaid, S. Cheema, M. Akbar, N. Alrajeh, M. S. Alabed and N. Guizani, "Balanced Energy Consumption Based Adaptive Routing for IoT Enabling Underwater WSNs," in IEEE Access, vol. 5, pp. 10040-10051, 2017.

[19] G. Hatzivasilis, I. Papaefstathiou and C. Manifavas, "SCOTRES: Secure Routing for IoT and CPS," in IEEE Internet of Things Journal, vol. 4, no. 6, pp. 2129-2141, Dec. 2017.

[20] C. Aranzazu-Suescun and M. Cardei, "Distributed algorithms for event reporting in mobile-sink WSNs for Internet of Things," in Tsinghua Science and Technology, vol. 22, no. 4, pp. 413-426, Aug. 2017.

[21] S. Mukherjee, S. Sriram, T. Vu and D. Raychaudhuri, "EIR: Edge-aware inter-domain routing protocol for the future mobile internet", Computer Networks, vol. 127, pp. 13-30, 2017.

[22] F. Al-Turjman, "Cognitive routing protocol for disaster-inspired Internet of Things", Future Generation Computer Systems, 2017.

[23] J. Kua, S. Nguyen, G. Armitage and P. Branch, "Using Active Queue Management to Assist IoT Application Flows in Home Broadband Networks", IEEE Internet of Things Journal, vol. 4, no. 5, pp. 1399-1407, 2017.

[24] S. Barker, D. Irwin and P. Shenoy, "Pervasive Energy Monitoring and Control Through Low-Bandwidth Power Line Communication", IEEE Internet of Things Journal, vol. 4, no. 5, pp. 1349-1359, 2017.

[25] C. Tsai, "SEIRA: An effective algorithm for IoT resource allocation problem", Computer Communications, 2017.

[26] J. Shen, A. Wang, C. Wang, P. C. K. Hung and C. F. Lai, "An Efficient Centroid-Based Routing Protocol for Energy Management in WSN-Assisted IoT," in IEEE Access, vol. 5, pp. 18469-18479, 2017.

AUTHORS PROFILE

Abdul Wasay Mudasser Received his B.tech, M.tech degree from JNTUH Hyderabad in the year 2007 and 2010 respectively. Presently Pursuing Ph.D. in Department of Electronics and Communication Engineering from Himalayan University, Arunachal Pradesh, India in the field of Wireless Sensor Network. His field of interest is Wireless Sensor Networks, Wireless Communication Networks

Shaik Mohammed Rasool Received the B.tech, M.tech degree both in Electronics and Communications from JNTUH Hyderabad, India in the year 2007 and 2013 respectively. Presently Pursuing Ph.D. Department of Electronics and Communication Engineering from Himalayan University, Arunachal Pradesh, India in the field of Wireless Body Area Network.

Dr. Shah Aqueel Ahmed Abdul Gafoor received B.E, M.E degree both in Electronics from Swami Ramanand Theerth Marathwada University Maharashtra, India in the year 1991 and 2004 respectively. He Completed his first Ph.D. in Electronics & Computer Engineering from Floret Global University, Panama, Republic of Panama. He completed his second Ph.D. in Electronics & Communication Engineering from GITAM, Hyderabad, India in the year 2015. Presently he is Professor and Principal in Maulana Mukhtar Ahmad Nadvi Technical Campus, Maharashtra, India.